REMARKS

Applicant respectfully requests reconsideration of this application as amended. Claims 1-6, 8, 9, and 24 are canceled. Claims 7, 10-23, and 25-29 are currently pending in this application.

Claim Rejections - 35 U.S.C. §103(a)

Claims 7, 10-23, and 25-29 have been rejected under 35 U.S.C. §103(a) as being unpatentable over Reinhardt (U.S. Patent No. 6,747,243) in view of Allen (U.S. Patent Publication 2004/0182416) and Yogev (U.S. Patent No. 6,799,584).

Claims 10-11 have been rejected under 35 U.S.C. §103(a) as being unpatentable over Reinhardt, Allen, and Yogev, as stated above and further in view of Borden (U.S. Patent No. 6,066,032).

Claims 10-11 have been rejected under 35 U.S.C. §103(a) as being unpatentable over Reinhardt, Allen, and Yogev, as stated above and further in view of Franca (U.S. Patent No. 6,217,422).

Response to 35 U.S.C. §103(a) rejections

With regard to the rejection of claims 7, 10-23, and 25-29 under 35 U.S.C. §103(a) as being unpatentable over Reinhardt in view of Allen and Yogev, applicant submits that the combination of prior art references of Reinhardt, Allen and Yogev would not render the present invention obvious because these references fail to teach an element of the present invention, namely causing the particle defect to undergo an explosive evaporation, which comprises evaporation and fragmentation of the particle defects.

The present invention presents a laser beam providing energy to a particle defect to cause the defect to undergo explosive evaporation, defined as partially evaporation and partially fragmentation. Thus in the laser ablation process according to the present invention, the particle partially vaporizes and partially breaks into smaller particle fragments.

Applicant submits that Reinhardt fails to teach evaporating and fragmentizing the particle defects using a laser beam. Reinhardt is silent with respect to evaporate and fragmentize the particle defect, and employs a laser beam to provide thermal shock

(Reinhardt, Col. 11, line 37; Col. 11, lines 47-48), where the particle undergoes rapid temperature changes, generating expansion/contraction at the contacting surfaces, reducing the adhesion of the particle to the substrate surface, and thus struck loose and may be carried away by a nitrogen flow (Reinhardt, Col. 11, lines 66-67). Thus applicant submits that Reinhardt discloses a laser process where the particle defect is removed intact, and not evaporated or fragmentized.

Further, Reinhardt teaches that the laser tool removes the particles indiscriminant of materials or composition (Reinhardt, Col. 11, line 45-46), and therefore it is not necessary to adjust or change the laser beam based on the composition of the defect. Thus applicant submits that Reinhardt teaches away from the invention of using the laser beam to evaporate the defect, since the energy needed for evaporation is highly dependent on materials or compositions.

It is appreciated that the Examiner also acknowledges that Reinhardt fails to teach explosive evaporation (Office Action dated 7/24/2008, page 3).

With regard to Allen, applicant submits that Allen is also silent with respect to evaporating and fragmentizing the particle defect. Allen discloses a process of coating the substrate surface with a transfer medium, and then using a pulsed energy beam to cause explosive evaporation of the transfer medium (Paragraph [0039], line 11). The particle defect is removed intact; only the transfer medium undergoes explosive evaporation, which lifts off the transfer medium layer together with the intact, embedded particle defect (Paragraph [0039], lines 13-14; Fig. 2C). Thus applicant submits that Allen discloses an explosive evaporation of the <u>transfer medium</u> at the substrate surface, which generates enough energy to explosively pushing the transfer medium with the intact embedded defects from the substrate surface. Allen's laser process does <u>not</u> cause the particle defect to undergo an explosive evaporation, and does <u>not</u> cause evaporation or fragmentation of the particle defect.

The Examiner stated that Allen teaches that explosive evaporation is used to remove particles with substantial force, and that a thermal expansion velocity removes the particle. Applicant submits that the explosive evaporation process of Allen is directed toward the transfer medium/substrate interface, which lifts the transfer medium away from the substrate. The particle defect is embedded in the transfer medium and thus is

removed intact with the transfer medium. Thus applicant submits that Allen teaches explosive evaporation of the transfer medium and fails to teach explosive evaporation of the particle defect, which comprises evaporation and fragmentation.

Thus applicant submits that Allen fails to teach explosive evaporation of the defect particle by laser ablation, and also fails to teach evaporation and fragmentation of defect particle by laser ablation.

With regard to Yogev, applicant submits that Yogev is silent with respect to evaporating the particle defect with the laser. Yogev discloses coating the particles on the semiconductor substrate with a fluid and then applying suction to release and remove the particles from the surface. Yogev found that wetting the surface prior to applying suction is more effective in removing particles than applying suction alone. Yogev also discloses applying laser energy to the surface to aid in the release of the particles from the surface. There is no mentioning of evaporating the particle defect with the laser.

Further, with regard to defect fragmentation, applicant submits that Yogev teaches away from defect particle fragmentation by a laser ablation process. Yogev discloses that defect particles tend to explode during a laser cleaning process, and teaches away from defect fragmentizing by listing potential drawbacks of the particle explosion process, such as substrate surface damage upon the explosion, difficulty of removing particles and particle fragments of different contaminants and large range of sizes (Col. 2, lines 1-3). Further, Yogev discloses that his inventive process substantially reduces or eliminates particle explosion phenomena (Col. 3, lines 25-27; Col. 4, lines 42-43; Col. 5, lines 19-20). In an exemplary process, Yogev discloses that none of the silicon nitride particles exploded, as compared to a conventional laser cleaning process having more than 80% of the particles exploded.

The Examiner stated that Yogev discloses the use of laser cleaning and the explosion of a particle and fragments thereof. Applicant submits that Yogev mentions particle fragmentation, but teaches away from fragmenting particles as discussed above.

In sum, applicant submits that Reinhardt, Allen and Yogev all are silent with respect to the process of using a laser beam for causing a particle defect to undergo an explosive evaporation, which comprises evaporation and fragmentation of the particle defect. Applicant submits that Reinhardt, Allen and Yogev all are silent with respect to

the process of using a laser beam for vaporizing the particle defect. Also, applicant submits that Reinhardt and Allen are both silent with respect to fragmentizing the particle defect, and Yogev teaches away from fragmentizing the particle defect. Thus applicant submits that the combination of these references would not render obvious the present claims of laser ablating a particle defect, causing explosive evaporation of the particle defect, which comprises partial evaporation and partial fragmentation of the particle defect.

With respect to claims 12 and 13, applicant submits that dependent claims 12 and 13 are patentable, at least for the reason stated above with respect to the independent claim 7. Additionally, dependent claims 12 and 13 are patentable in view of Reinhardt, Allen and Yogev for the reasons stated below.

Claims 12 and 13 are directed to focusing the laser beam to a point above the wafer surface at a distance approximately equivalent to the approximate radius of the particle defect. The distance is between about 1μm to about 10μ above the wafer surface (claim 13). Focusing the laser beam above the wafer surface can reduce the damage to the wafer surface caused by the laser beam. For example, during laser ablation, a high energy plasma plume may form as a result of the rapid thermal gradient. Focusing above the wafer surface can cause the high energy plasma plume to be further away from the wafer surface, thus reducing the damage to the wafer surface. Also, in the event that the laser beam misses the particle, the laser beam is not focused directly on the wafer surface, thus reducing the potential damage.

The present claims are patentable in view of Reinhardt, Allen and Yogev since these references each fails to teach at least an element of the present claims, namely focusing the laser beam to position a focal point of the laser beam to be above the wafer surface at a distance approximately equivalent to the approximate radius of the particle defect.

Applicant submits that Reinhardt fails to teach focusing the beam to a point above the wafer surface. Reinhardt discloses directing a laser beam at the particle defect to remove such defect by thermal shock, but Reinhardt is silent with respect to the location of the focal point of the laser beam. Thus Reinhardt fails to teach focusing the beam to a point above the wafer surface.

With regard to Allen, applicant submits that Allen discloses coating the substrate surface with a transfer medium, and then directing a pulsed energy source (e.g., a laser beam) to the substrate to cause explosive evaporation on the transfer medium. Allen is silent with respect to focusing the beam to a point above the wafer surface. Thus Allen fails to teach focusing the beam to a point above the wafer surface.

With regard to Yogev, applicant submits that Yogev discloses applying laser energy to the surface to aid in the release of the particles from the surface. However, Yogev is silent with respect to focusing the laser to position a focal point of the laser beam to be above the wafer surface at a distance approximately equivalent to the approximate radius of the particle defect.

Thus applicant submits that the combination of Reinhardt, Allen and Yogev does not render obvious the present claims since the prior art references of Reinhardt, Allen and Yogev each fails to teach focusing the laser beam to position a focal point of the laser beam to be above the wafer surface at a distance approximately equivalent to the approximate radius of the particle defect. Thus the present claims are patentable in view of Reinhardt, Allen and Yogev.

With respect to claim 18, applicant submits that dependent claim 18 is patentable, at least for the reason stated above with respect to the independent claim 17. Additionally, dependent claim 18 is patentable in view of Reinhardt, Allen and Yogev for the reasons stated below.

Claim 18 claims that the particle defect detector includes a low energy laser to detect the particle defects above the wafer surface and produce signals containing data about the particle defects physical properties and location. The physical properties of the particle defects can help in controlling power, time-frequency pulsing, or other electronics functions of the short pulse laser.

The present claim is patentable in view of Reinhardt, Allen and Yogev since these references each fails to teach at least an element of the present claims, namely a low energy laser to detect the particle defects above the wafer surface and produce signals containing data about the particle defects physical properties and location.

Applicant submits that Reinhardt fails to teach a low energy laser to detect the particle defects. Reinhardt employs an inspection system to optically or electronically

scan the substrate surface to detect and locate the defects (Col. 8, lines 22-27). The inspection system may include optical or SEM instruments (Col. 8, lines 29-30). Reinhardt is silent with respect to a low energy laser.

Further, Reinhardt is silent with respect to detecting and producing signals containing the physical properties of the defects. Reinhardt discloses software component adapted to identify the materials or composition of each located contaminant (Col. 8, lines 64-66). However, Reinhardt discloses that the laser removes the defects indiscriminant of the material and composition of such defect, as a result of the laser beam removing the defect by thermal shock (Col. 11, lines 45-48). Thus the inspection system according to Reinhardt is unlikely to produce data about the physical properties of the defect.

With regard to Allen, applicant submits that Allen is silent with respect to a particle defect detector includes a low energy laser to detect the particle defects above the wafer surface and produce signals containing data about the particle defects physical properties and location.

Applicant also submits that Yogev is silent with respect to a particle defect detector includes a low energy laser to detect the particle defects above the wafer surface and produce signals containing data about the particle defects physical properties and location.

Thus applicant submits that the combination of Reinhardt, Allen and Yogev does not render obvious the present claims since the prior art references of Reinhardt, Allen and Yogev each fails to teach a particle defect detector includes a low energy laser to detect the particle defects above the wafer surface and produce signals containing data about the particle defects physical properties and location. Thus the present claims are patentable in view of Reinhardt, Allen and Yogev.

With respect to claims 21 and 28, applicant submits that dependent claims 21 and 28 are patentable, at least for the reason stated above with respect to the independent claims 17 and 25, respectively. Additionally, dependent claims 21 and 28 are patentable in view of Reinhardt, Allen and Yogev for the reasons stated below.

Claims 21 and 28 claim that the processing device utilizes the data of the particle defects to compute their physical properties, which the particle defect ablator can utilize

to control power, time frequency pulsing, or other electronic functions of the short pulse laser.

The present claim is patentable in view of Reinhardt, Allen and Yogev since these references each fails to teach at least an element of the present claims, namely utilizing data of the particle defects to compute their physical properties to help the particle defect ablator to control power, time frequency pulsing, or other electronic functions of the short pulse laser.

Applicant submits that Reinhardt fails to teach using physical properties of the particle defects to control power, time frequency pulsing, or other electronic functions of the short pulse laser. Reinhardt discloses that the laser removes the defects indiscriminant of the material and composition of such defect, as a result of the laser beam removing the defect by thermal shock (Col. 11, lines 45-48). Thus the ablation laser according to Reinhardt is unlikely to utilize data about the physical properties of the defect.

With regard to Allen, applicant submits that Allen is silent with respect to using physical properties of the particle defects to control power, time frequency pulsing, or other electronic functions of the short pulse laser.

Applicant also submits that Yogev is silent with respect to using physical properties of the particle defects to control power, time frequency pulsing, or other electronic functions of the short pulse laser.

Thus applicant submits that the combination of Reinhardt, Allen and Yogev does not render obvious the present claims since the prior art references of Reinhardt, Allen and Yogev each fails to teach using physical properties of the particle defects to control power, time frequency pulsing, or other electronic functions of the short pulse laser. The present claims are patentable in view of Reinhardt, Allen and Yogev.

With respect to other dependent claims, applicant submits that these dependent claims should be allowable, at least for the reason stated above with respect to the independent claims.

With respect to the rejection of claims 10-11 as being unpatentable over Reinhardt, Allen, Yogev and Borden, applicant submits that dependent claims 10 and 11 are patentable, at least for the reason stated above with respect to the independent claim 7.

Additionally, dependent claims 10 and 11 are patentable in view of Reinhardt, Allen, Yogev and Borden for the reasons stated below.

Claims 10 and 11 are directed to focusing the laser beam so that a focal point of the laser beam contacts the particle defect at a low incidence angle. The low incident angle is between about 5° to about 30° from the wafer surface (claim 11). The low incident angle potentially can reduce the damage to the wafer surface caused by the laser beam. For example, during laser ablation, a high energy plasma plume may form as a result of the rapid thermal gradient. A low incident angle can cause the high energy plasma plume to shift up and away from the wafer surface, thus reducing the damage to the wafer surface. Also, the amount of reflected energy increases with a low incident angle, thus in the event that the laser beam misses the particle, the low incident angle laser beam will direct less energy into the wafer surface.

The present claims are patentable in view of Reinhardt, Allen, Yogev and Borden since these references each fails to teach at least an element of the present claims, namely directing the laser beam so that a focal point of the laser beam contacts the particle defect at a low incidence angle.

Applicant submits that Reinhardt, Allen and Yogev all fails to teach focusing the beam at a low incident angle from the wafer surface. It is appreciated that the Examiner also acknowledges that Reinhardt fails to teach the angle of incident (Office Action dated 7/24/2007, page 4).

With regard to Borden, applicant submits that Borden discloses applying a laser to heat the surface of a wafer to compensate for the cooling effect of the CO_2 snow spray (Col. 2, lines 1-4; Col. 2, lines 56-57; and Col. 3, lines 54-57). The size of the laser beam may be expanded to optimize heating of an area that is cooled by the snow spray. Borden is silent with respect to focusing a laser beam onto a particle defect at a low incident angle. In addition, the CO_2 spray coming from a jet spray nozzle at a shallow angle can cover a large area of the wafer, as shown in Fig. 1. Thus applicant submits that Borden fails to disclose focusing a laser beam onto a particle defect at a low incident angle.

In addition, applicant submits the prior art of Borden is incompatible with those of Reinhardt, Allen, and Yogev since the laser beam of Borden provides a different principle of operation. Borden discloses using a broad laser beam for heating the wafer surface for

compensating the cleaning action of the CO_2 spray, while Reinhardt focuses a laser beam onto a particle defect for ablation. Thus it is not obvious that the low angle of a broad laser beam for wafer surface heating can be applied to a focusing laser beam onto a particle defect for ablating the particle defect.

With respect to the rejection of claims 10-11 as being unpatentable over Reinhardt, Allen, Yogev and Franca, applicant submits that dependent claims 10 and 11 are patentable, at least for the reason stated above with respect to the independent claim 7. Additionally, dependent claims 10 and 11 are patentable in view of Reinhardt, Allen, Yogev and Franca since these references each fails to teach at least an element of the present claims, namely directing the laser beam so that a focal point of the laser beam contacts the particle defect at a low incidence angle.

Applicant submits that Franca discloses applying a laser to an area of a CMP pad surface, to generate steam or vapor to assist in the cleaning process (Col. 3, lines 15-16; Col. 4, lines 41-42; Col. 7, lines 48-52). The size of the irradiated area is in the order of cm (Col. 7, lines 48-52). The laser beam at a shallow angle covers a large area of the CMP pad, as shown in Figs. 2-6. Franca is silent with respect to <u>focusing</u> a laser beam onto a particle defect at a low incident angle. Thus applicant submits that Franca fails to disclose focusing a laser beam onto a particle defect at a low incident angle.

In addition, applicant submits the prior art of Franca is incompatible with those of Reinhardt, Allen, and Yogev since the laser beam of Franca provides a different principle of operation. Franca discloses using a broad laser beam for heating the surface of a CMP pad, generate steam or vapor to assist in a pad cleaning process. Thus it is not obvious that the low angle of a broad laser beam for CMP pad heating can be applied to a focusing laser beam onto a particle defect for ablating the particle defect.

In conclusion, applicants respectfully submit that in view of the amendments and arguments set forth herein, the applicable rejections have been overcome.

Pursuant to 37 C.F.R. § 1.136(a)(3), applicant(s) hereby request and authorize the U.S. Patent and Trademark Office to (1) treat any concurrent or future reply that requires a petition for extension of time as incorporating a petition for extension of time for the appropriate length of time and (2) charge all required fees, including extension of time fees and fees under 37 C.F.R. §§ 1.16 and 1.17, to Deposit Account No. 02-2666.

Respectfully submitted,

BLAKELY, SOKOLOFF, TAYLOR & ZAFMAN

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